G M Crops

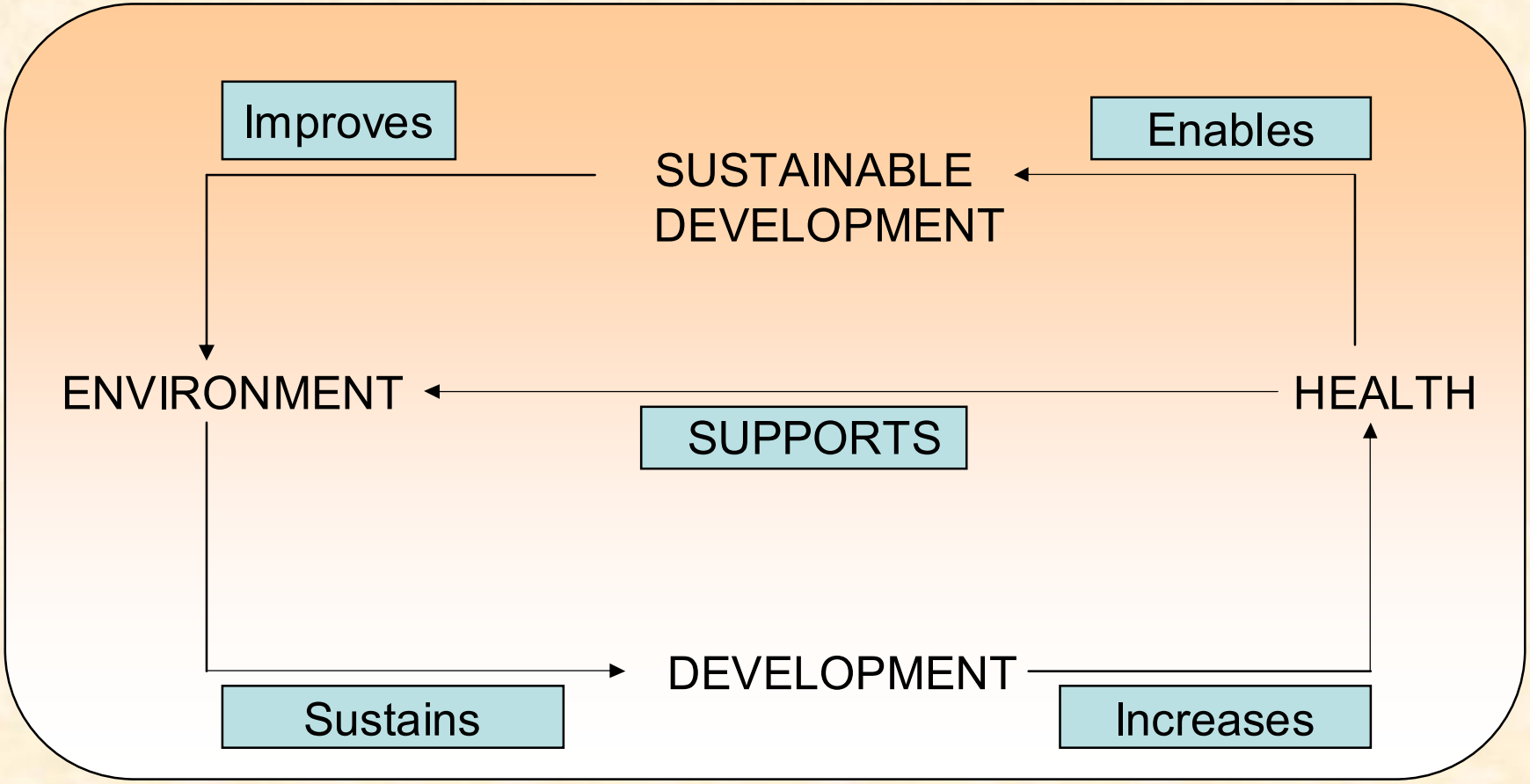
By
Durga Madhab Mahapatra,
Ist Yr M.S.(Engg.),CST
IISc, Bangalore.

Contents

- Introduction to Technology
- Usage of technology in terms of Social welfare
- Sustainability in the context of Technology
  - * Socio-economic Concerns
  - * Environmental aspects
  - * Health Concerns
- Structure & Morphology of GM Crops
- Systems approach in terms of Env, Soc & Eco.
- Sustainability Indicators
- Simulation by cross impact analysis
- Conclusions

Sustainability

- It is the ability to sustain or continue or persist indefinitely over time.
- Sustainable development is the development that meets the need of the present, without compromising the ability of the future generation to meet their own needs.



Introduction

What are genetically modified Crops?

- GM crops are crop plants which have their genome altered & have been modified in the laboratory to enhance desired traits using the latest molecular biology techniques.

The Technology-Genetic engineering

- Genetic engineering creates plants with the exact desired trait very rapidly and with great accuracy.e.g. isolate a gene responsible for pest tolerance and insert that gene into a different plant.

- The B.t. genes in corn and other crops. B.t., or *Bacillus thuringiensis*, is a naturally occurring bacterium that produces crystal proteins that are lethal to insect larvae.

How it all began!

- In the Nineties, GM Crops moved out of the laboratory into farms and became quite famous. G M foods have been available since 1990's.
- The first commercially grown genetically modified food crop was the Flavr Savr tomato(Approved for sale in 1994).
- After this a variant of the Flavr Savr was used by Zeneca to produce tomato paste which was sold in Europe during the summer of 1996.
- Introduction of Monsanto's "Roundup-Ready" soybeans during the same period.
- The next GM crops included insect-protected cotton and herbicide-tolerant soybeans both of which were commercially released in 1996-97.
- Other GM crops as insect-protected maize and herbicide-tolerant maize, cotton, and rapeseed varieties were developed by 2000.

Technology

Technology: Consists of two components:

1. **Technology as an entity (physical existence)**
   - ***Macro level-G M crop**
   - ***Micro level –engineered gene**

2. **Technology with knowledge embodied (knowledge content)**
   Genetic engineering

Type of Technology:

- At the macro level it is an active technology i.e. A technology in which there is continuous energy transfer.
- At the micro level it can be said as a passive technology i.e. A technology in which there is no apparent continuous energy transfer

The main intent of introduction of the Technology –

- Introduction of G M crops was to prevent the loss of food grains due to pests which adds to food surplus and direct the soil nutrients only to the crops for their better growth.
- Though the prime concern for the dissemination of this technology was a corporate control over agriculture and profit assuming the GM Crop as a commodity ready for the sale.

Gene Isolation

Desired gene identification

Restriction digestion

Incorporation of the Gene into vectors

Screening

infecting the plant cell with the bacteria

Gene product analysis

Incorporation of the chimera into bacteria

Expression of gene in bacteria

Technology	Methods for the Design of technology	Embodied technologies
Genetically engineered Crops	1.Methods of gene incorporation	1.Gene gun (Gene-targeting) 2.Electroporation 3.Micro-injection 4.Plasmid vectors 5.Ti plasmids
	2.Methods of analysis for the workability of the gene	1.Screening technique 2. Antibiotic resistance 3. Marker analysis. 4. Colony hybridization
	3.Methods for tracking the gene	1.Native poly acrylamide gel electrophoresis 2.SDS PAGE 3..CTAB Analysis
	4.Methods of gene synthesis	1.Gene Amplification by Polymerase Chain Reaction 2.Cloning 3.Expression Cassette
	5.Methods of insertion of gene into particular location	1.Random priming 2.End labeling

Sustainability in the context of Technology

For a Society to be sustainable in the context of the technology-G M Crops

- It should benefit society

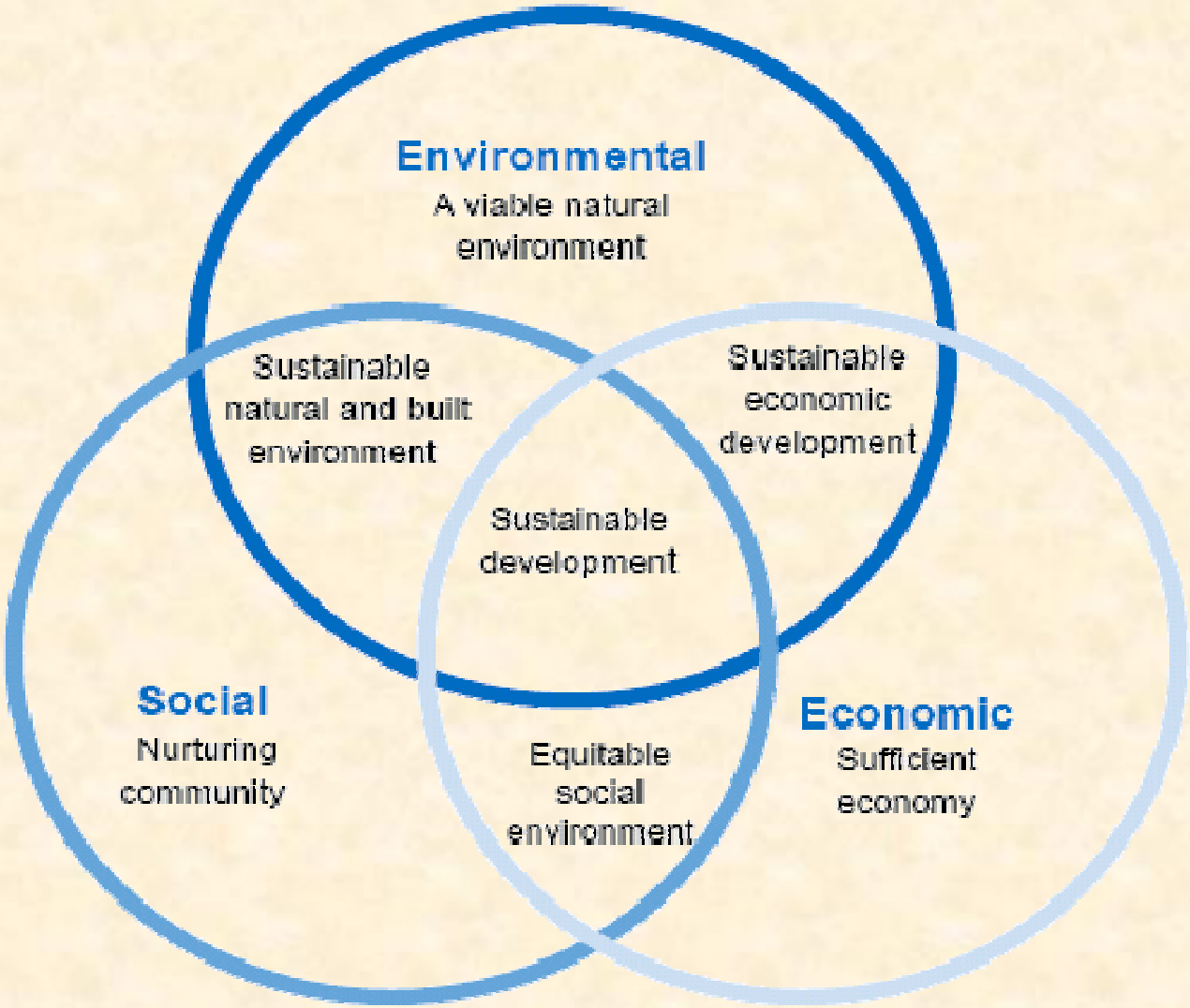
1. A better access & choices to food
2. Reduction in starvation deaths-
3. Future food security- Present & future generation
4. More nutritious food – Enriched with Vit-A, Calcium, Proteins

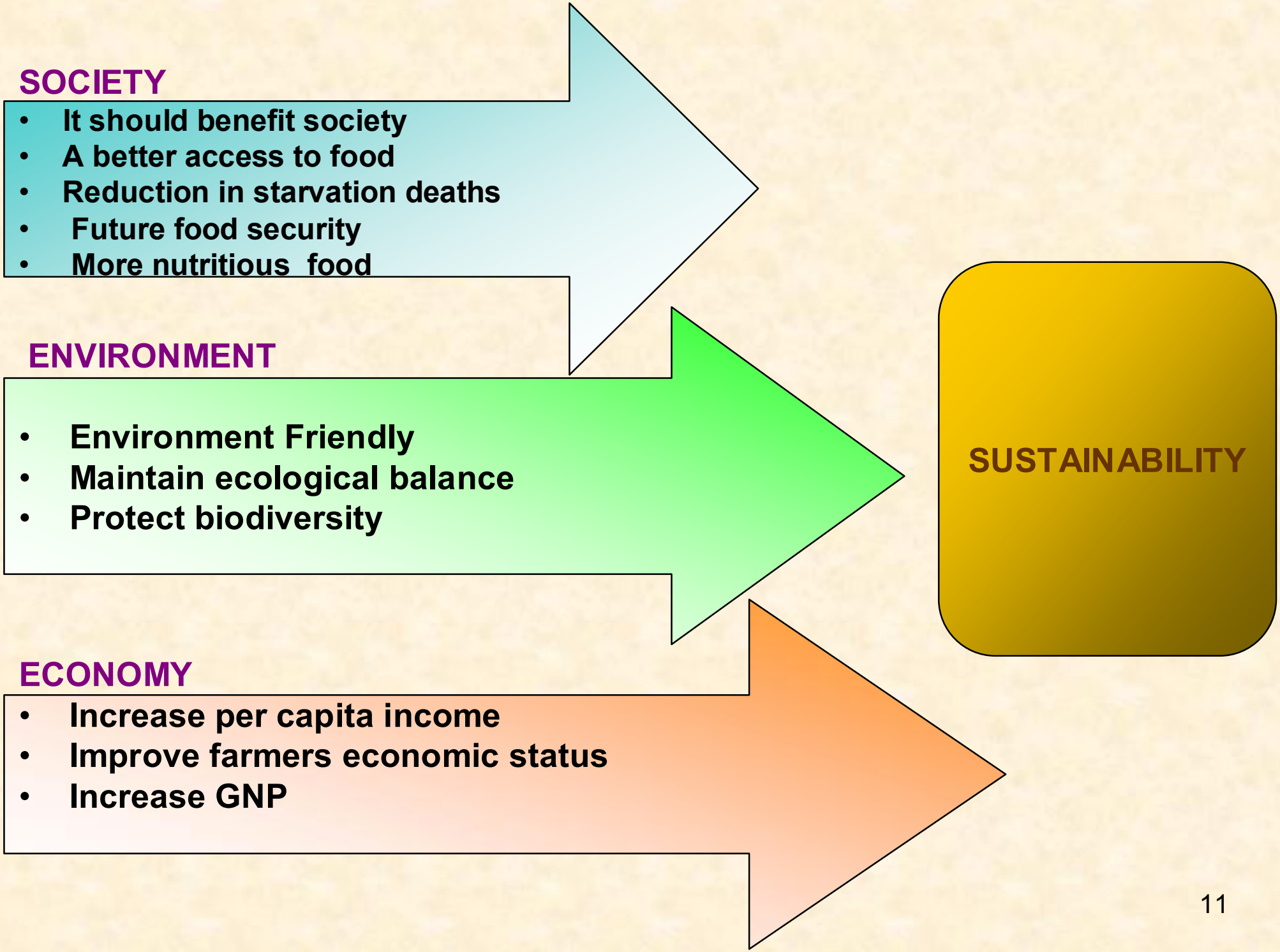
- It should benefit environment

1. Should be environment Friendly- do not increase pollution
2. Maintain ecological balance
3. Protect biodiversity

- It should benefit the economy

1. Increase per capita income.
2. Improve farmers economic status
3. Increase GNP


Environmental
A viable natural environment
Sustainable natural and built environment
Sustainable economic development
Sustainable development
Social
Nurturing community
Equitable social environment
Economic
Sufficient economy


SOCIETY
• It should benefit society
• A better access to food
• Reduction in starvation deaths
• Future food security
• More nutritious food
ENVIRONMENT
• Environment Friendly
• Maintain ecological balance
• Protect biodiversity
ECONOMY
• Increase per capita income
• Improve farmers economic status
• Increase GNP
SUSTAINABILITY

Indicators of sustainability

Positive Aspects:-

- Surplus productivity (increase in global Food yield)
- Reduction in use of pesticides, Chemical fertilizers & herbicides.
  - less water contamination
  - less eutrophication
- Soil integrity- conservation tilling.
  - Maintains soil microflora, Earthworms (detritus status)
  - Lowering soil erosion.
- Reduction in CO_2 emissions.
- Improvement in
  1. Food quality -Sugar beet
  2. Durability/ Shelf life -Flavr savr Tomatoes
  3. Nutrition -Golden rice
- Withstand Environmental stress
  - Drought, Salty & Cold environments.

Negative Aspects :-

Environment

- Permanent Loss of germplasm
- Horizontal gene flow (Natural cross breeding & pollination)
- Loss in sp. Biodiversity
    - Monoculture (monocropping)
    - Loss of traditional crop cultivars
    - Reduction in bees,caterpilars (monarch butterfly)
    - Arthropods , Nematodes.
- Biomagnification
- Ecological imbalance – Effect on food chain

Health

- Immune disorders (stunted growth),
- Difference in kidney size & blood composition (Rats)
- Toxic to mammals
- Gut (Sub-mucosal) & colon cancer

Society

- Poor Farmers
    - Inability to buy seeds
      (Terminator seed technology G M Crops)
    - loss of traditional agricultural practices & traditional cultivars (indigenous species.)
    - dependence on agribiotech companies.

Economy

- Lowering agricultural economy (Corporate control over agriculture)
- More benefits to Biotech giants as Monsanto,Astrageneca etc.
- Quest for patents (Recovering R& D expenses)

Global regulations (International Trade)

- European council's ban on approval of U.S foods in Europe (De Facto Moratorium)
- Refusal of some African countries for U.S food aids
- EC demand for Labeling & Traceability.
- Non acceptance of G M Crops in European countries.
- Cartagina Protocol for Biosafety

GM Crops & Socio-Economic Changes:

- **Widening the gap between the wealthy and the poor**
  Due to high price of seeds small farmers and developing countries will not be able to afford seeds for GM crops

- **Patent infringement**
  Farmers may have to give heavy penalty for the patent infringement.

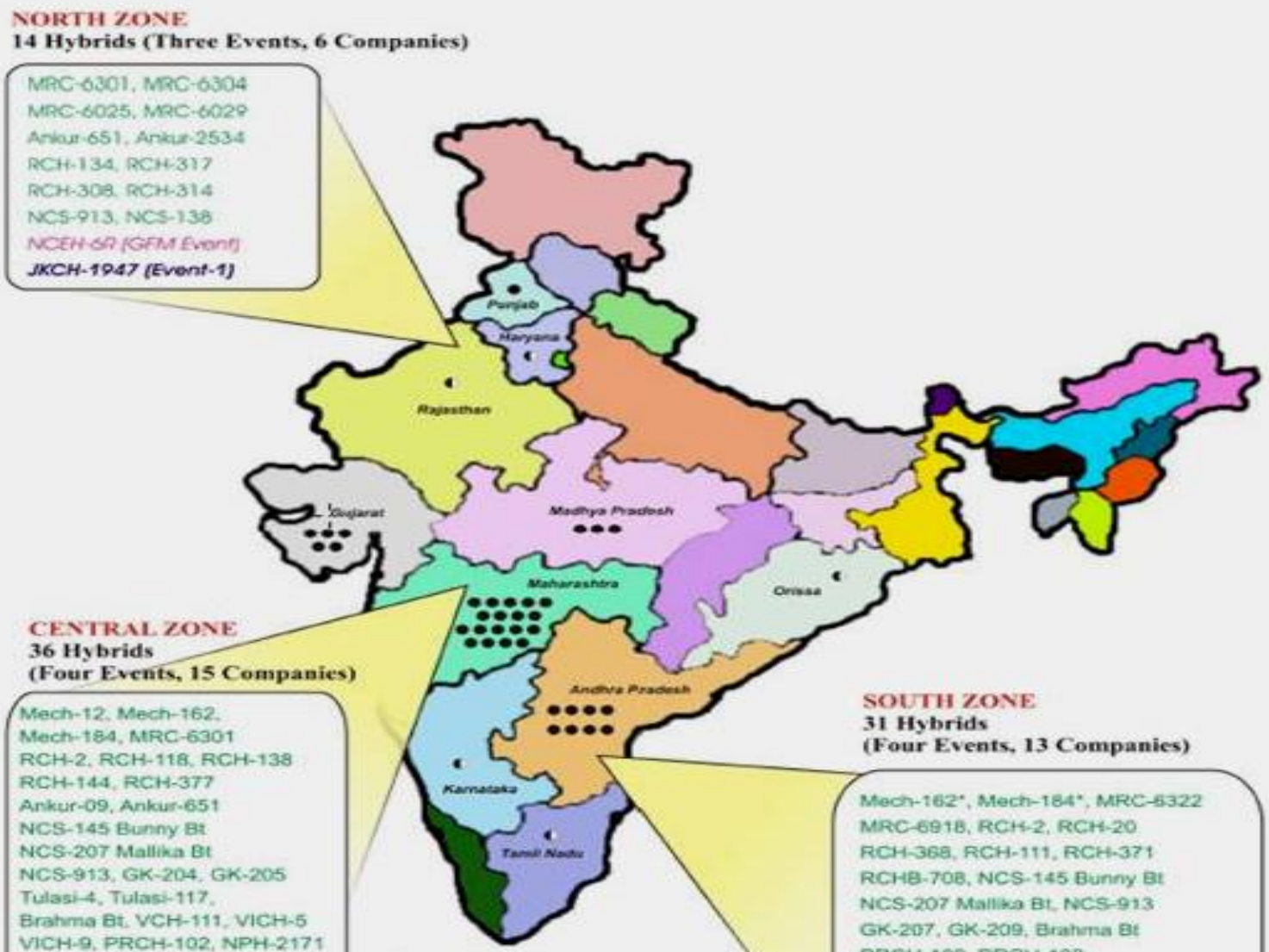
- **Suicide gene/Terminator seed Technology**
  Financially disastrous for farmers in developing countries who cannot afford to buy seed each year and traditionally set aside a portion of their harvest to plant in the next growing season.

Societal change due to introduction of this technology

There are a no. of Societal implications of this technology :

- It has been seen that a lot of people disagree to take food containing GM ingredients/G M foods as it affects moral and cultural values
- It is not wise for a developing country like India to introduce this technologies
- Bt Cotton varieties has given mixed results which was actually intended for better productivity, and had shown negative impacts of allergy. (pest resistant genes)
- The cultivation of food crops herbicide resistant genes should not be introduced to our country as a lot of families feed on some of the weeds as bathua, chaulai saag etc.
- In our country as in many places mixed cropping is practiced it will be very unwise to introduce the H. R varieties.

Approved Bt Cotton Hybrids in India (2006)



Bt Cotton (2002-2006): 62 Bt cotton hybrids commercially released, 106 in large-scale trials (LST)

Compiled by ISAAA, 2006

GM Crops & Environment (Environmental hazards)

Unintended harm to other organisms :

- Pollen from B.t. corn caused high mortality rates in monarch butterfly caterpillars.
- B.t. toxins kill many species of nematodes, arthropods (bees,caterpilars) & insect larvae indiscriminately;

Loss in biodiversity :

- Genetic diversity (gene pool)- There is permanent loss of pure germplasm by horizontal gene flow. Due to mixing or shuffling of genes pure lines of our old traditional cultivars cannot be established.

- Species diversity- Due to monoculture of newly emerged GM varieties our old traditional cultivable varieties indigenous for a place are lost for ever. Which results in reductions in local cultivars & increases dependence on GM crops.

Reduced effectiveness of pesticides

- Insects will become resistant to B.t. or other crops that have been genetically-modified to produce their own pesticides. (Super pests)

Gene transfer to non-target species :

- The gene transfer results in "super weeds" which are herbicide tolerant.

Biomagnification :

- There can be a danger of glyphosate/gluphosonate to be in the food chain. Which ultimately results in ecological imbalance.

GM Crops & Health Concerns (Human health risks)

- Allergenicity : Many children in the US and Europe have developed life-threatening allergies to peanuts and other foods.

- Toxic GM potatoes :Rats fed on potatoes genetically engineered to had suffered serious damage to their immune systems and shown stunted growth.

  The lectin expressed by the genetically modified potatoes is toxic to insects and nematodes and is allegedly toxic to mammals

  When fed with GM Round up ready soya there were variable effects on different parts of the rat gastrointestinal tract.

- Dangerous corn : A 90-Day Rat Feeding Study on the MON863 strain of GM corn conducted in May 2005, pointed the differences in kidney size and blood composition found in this study.

- Transfer of antibiotic resistance genes :For instance, antibiotic-resistance genes are used in some genetically modified plants as a marker of genetic transformation. These resistance genes can spread from the plant, & can be uptaken by a bacteria or virus.

- Cancer : There can be cauliflower virus used in GM foods could increase the risk of stomach and colon cancers.

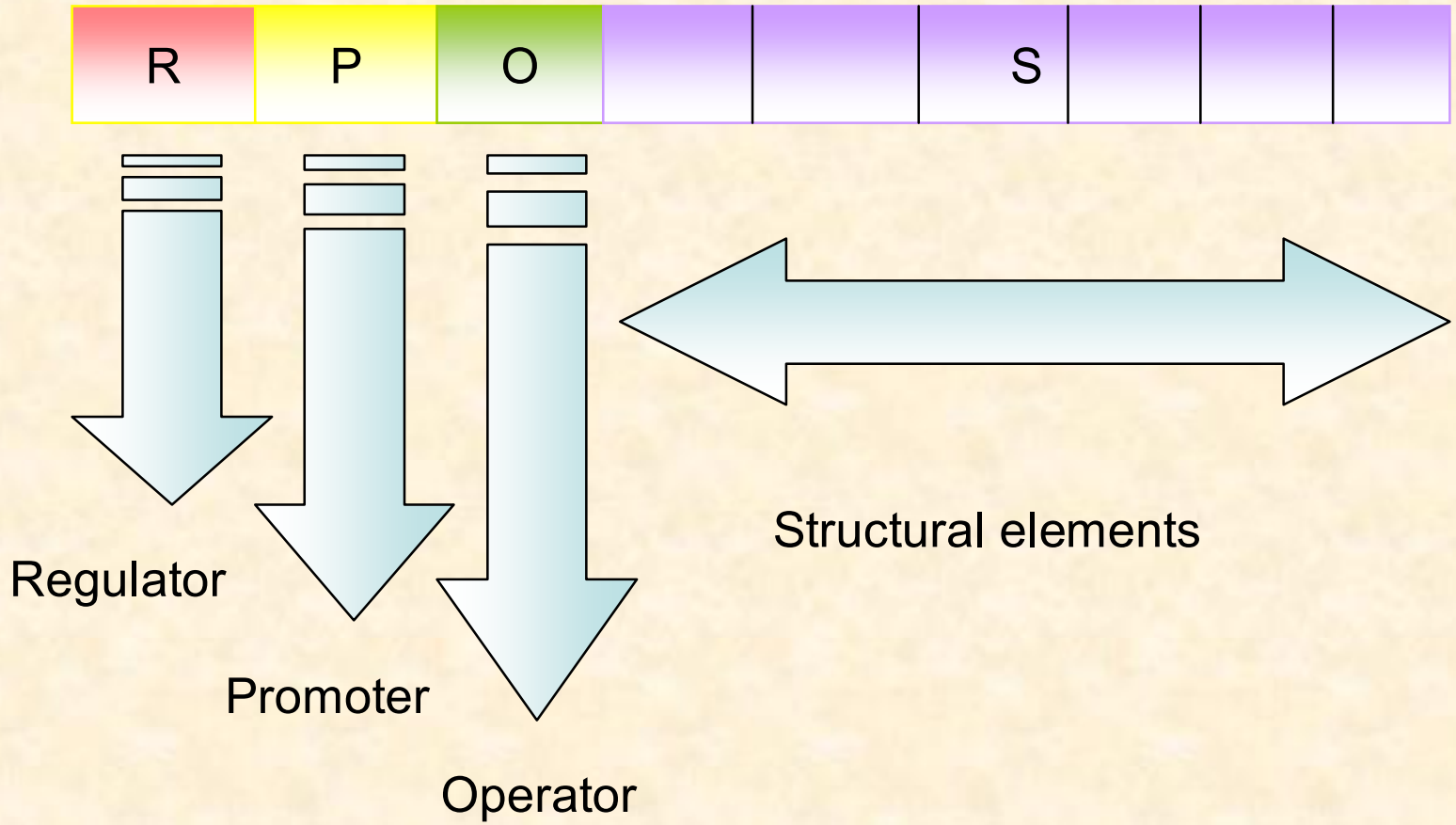
- Unpredictable human diseases :GM food and feed may be linked to chronic illnesses such as autoimmune disease, slow viruses or cancer which may be difficult to detect .

Structure & Morphology

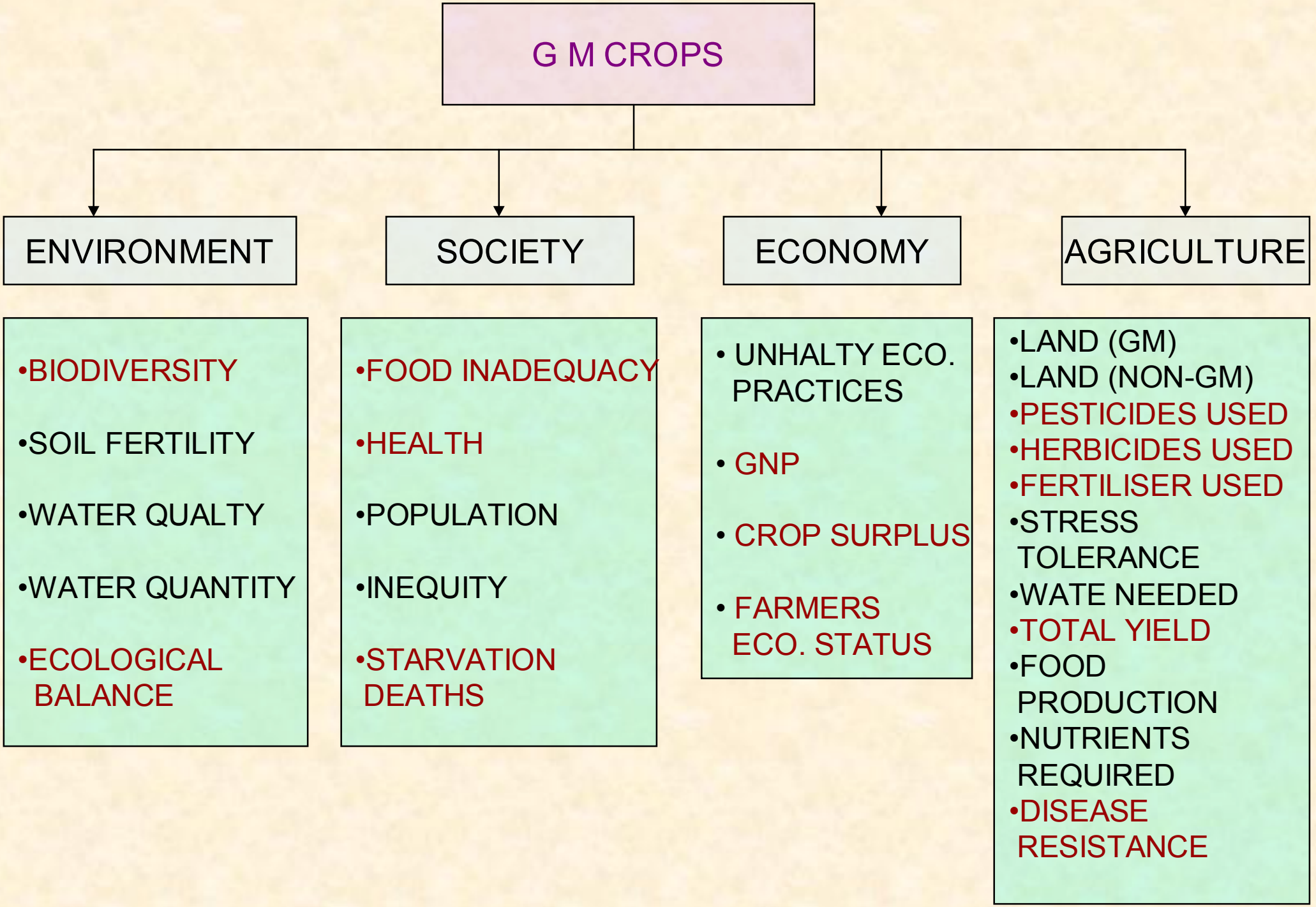
- Morphological Analysis (MA) represents the study of ‘structure’ and ‘form’, In the context of the present technology G M crops from gene to Crop.

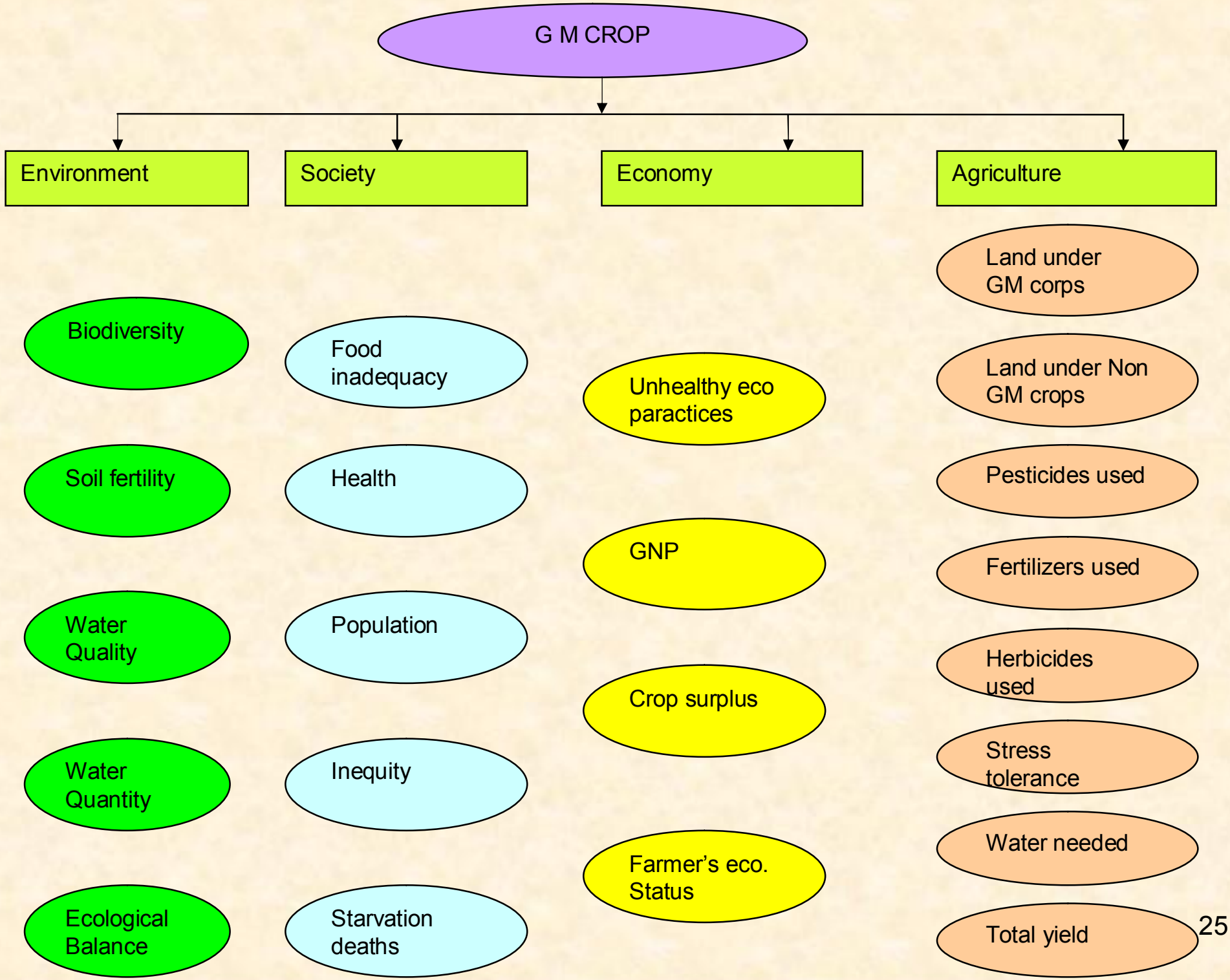
Dimensions	Functional characteristics considered under each dimension	Options
Micro level : Gene	**Varieties**	**Bt 134,Mon 863,Mon 822etc.**
	Expressibility	**High/Mod/Low**
	Yield due to gene	**High/Avg.**
	Length of gene	**10-40 kb,40-100 kb,100-200kb**
	(No. of nucleotides)	
	Strength of gene	**Ars promoters/Same gene**
	(powerful promoters)	**Promoters**
	Gene source	**Animal/plant/microbe.**
	Components	**Regulator**
		Promoter
		Operator
		Structural elements

A Gene construct



Dimensions	Functional characteristics considered under each dimension	Options
Macro level : GM Crop	Type Part intended to be modified Ext. shape Size Texture Colour Ht & width of growth Period Components Vegetative part Root Shoot Reproductive part	Cereals, Pulses ,Vegetables, Fruits Fruit, leaves etc. Herb, shrub, tree, climbers. .Big/Small Woody (more lignin), soft, tender etc. Green,Brown Tall/dwarf or Broad/Narrow. Biennial, perennial, annual Tap root, Adventitious roots Stem, branches, leaves Flower, Fruits

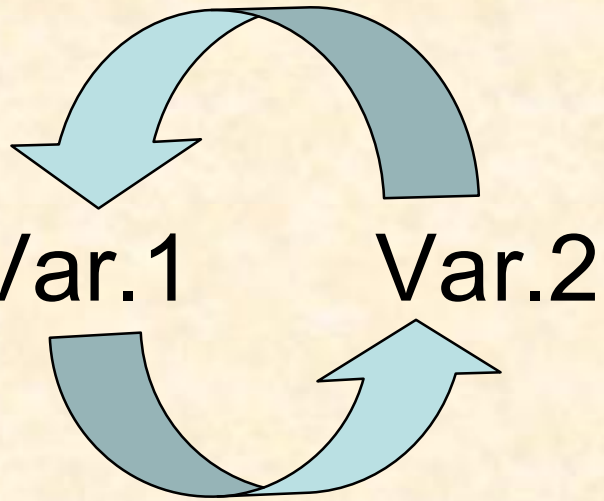

G M CROPS
ENVIRONMENT
SOCIETY
ECONOMY
AGRICULTURE
•BIODIVERSITY
•SOIL FERTILITY
•WATER QUALTY
•WATER QUANTITY
•ECOLOGICAL BALANCE
•FOOD INADEQUACY
•HEALTH
•POPULATION
•INEQUITY
•STARVATION DEATHS
• UNHALTY ECO. PRACTICES
• GNP
• CROP SURPLUS
• FARMERS ECO. STATUS
•LAND (GM)
•LAND (NON-GM)
•PESTICIDES USED
•HERBICIDES USED
•FERTILISER USED
•STRESS TOLERANCE
•WATE NEEDED
•TOTAL YIELD
•FOOD PRODUCTION
•NUTRIENTS REQUIRED
•DISEASE RESISTANCE


G M CROP
Environment
Society
Economy
Agriculture
Biodiversity
Soil fertility
Water Quality
Water Quantity
Ecological Balance
Food inadequacy
Health
Population
Inequity
Starvation deaths
Unhealthy eco paractices
GNP
Crop surplus
Farmer's eco. Status
Land under GM corps
Land under Non GM crops
Pesticides used
Fertilizers used
Herbicides used
Stress tolerance
Water needed
Total yield

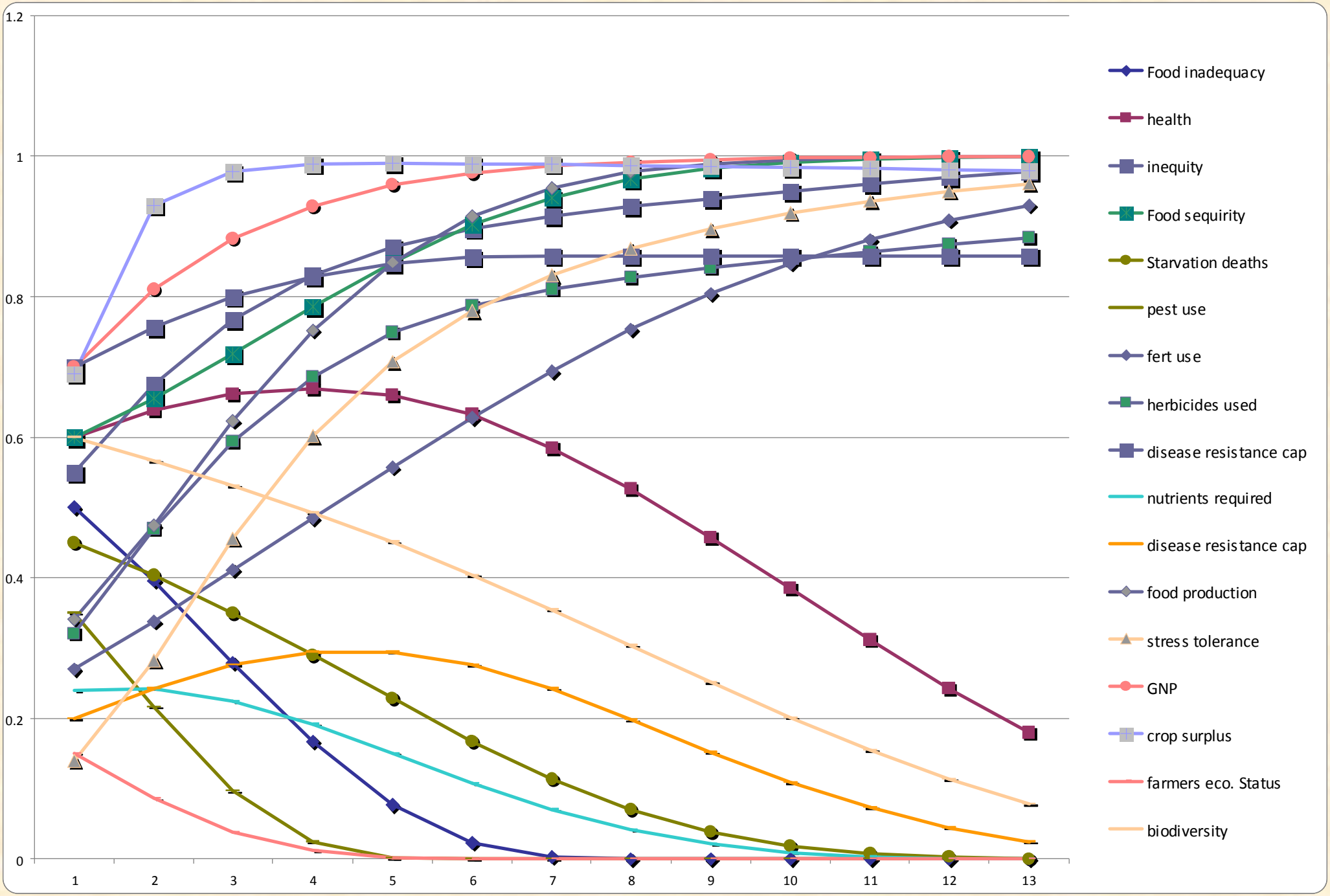
Simulation –Cross impact analysis

- The cross Impact analysis was performed by the Kane's simulation method

- System- G M crops
- Sub system- Env. Soc. Eco. Agriculture
- Variants-



Simulation Results



Conclusions

- It is well observable from the trends that GM Crops have an adverse effect on Environment as well as Health.
- A large number of countries are facing opposition from various quarters to the introduction to GM seeds and crops in their farmland. The issues involved include environmental, cultural, socio and economic concerns
- Particularly for a country like India the GM practices may not be successful.

- " Feeding or fooling the World " It is you who has to judge.

Recommendations

- All the countries and governments should carry out an adequate risk assessment exercise, stringent regulation measures & orders for right GM Crop approval to avoid the forthcoming impacts of GM Crops on Nature & human beings for a better sustainable future.


Thank You